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ORIGINAL ARTICLE

Effect of low pull headgear on head position

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KEYWORDS

Craniofacial morphology;
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Abstract *Objective:* To evaluate changes in head position following the use of low pull headgear (LHG) and compare these changes with an untreated control group.
Subjects and methods: The test group comprised pre-treatment and post-treatment lateral cephalograms of 30 males, aged 11 ± 1.5 years, who were receiving LHG therapy for correction of Class II malocclusion. Pre-observation and post-observation lateral cephalograms of 25 untreated male subjects, aged 11 ± 1.6 years, served as controls. The average treatment time for the treatment group was 12 ± 2.02 months and the average observation period for the control group was 11 ± 1.03 months. Four postural variables (NSL/CVT, NSL/OPT, CVT/HOR, OPT/HOR) were measured to evaluate the head position in all subjects pre- and post-observations.
Results: There was no significant difference in all the measurements concerning the head position within each group ($p > 0.05$). The mean differences of pre- and post-observations of 4 postural variables in the LHG group were 1.43, 0.9, −1.13, and −1.08, while those of the control group were 1.56, −0.32, −0.24, and 0.04, respectively. There was no significant difference between the headgear and control groups for any of the postural variables measured ($p = 0.924$, 0.338, 0.448, and 0.398, respectively).
Conclusions: Although postural variables showed considerable variability in both groups, head position exhibited no significant changes over a period of 11–12 months either in the control or headgear group.

1. Introduction

Recent years have witnessed a renewed interest in the interaction between form and function in the craniofacial region. Two physiologic factors have received particular attention with regard to their possible relation to craniofacial development viz., adequacy of the nasopharyngeal airway and postural relations of the head and the cervical column (Marcotte, 1981; Solow et al., 1984, 1996).

A review of the literature revealed that a developmental association exists between head position and craniofacial mor-

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phology. In extended head position, increased facial height, reduced sagittal dimensions and a steeper mandibular plane angle are generally observed, whereas when the head is flexed in relation to the cervical column there is shorter anterior facial height, larger sagittal jaw dimension and a less steep inclination of the mandible (Solow and Tallgren, 1976). Some longitudinal studies have likewise reported that growth changes in head position were associated with corresponding changes in the growth pattern of the facial skeleton. When the head was extended, a reduced forward rotation of the mandible was observed (Solow and Siersbaek-Nielsen, 1986, 1992).

Low pull headgear (LHG) is often used to redirect the maxillary growth in Class II malocclusion. This malocclusion is of particular interest to the practicing orthodontists since they constitute a significant proportion of total cases under treatment. Existing literature reports the effects of use of LHG on the position and growth of craniofacial structures. However, a very few studies reported the changes in head position following the use of LHG (Wieslander, 1974; Tulloch et al., 1997; Keeling et al., 1998; Yavuz et al., 2007). Therefore, we aimed to evaluate the changes in head position following the use of LHG and compare these changes with an untreated control group.

2. Methods

2.1. Subjects

The study sample consisted of 60 males (35 test and 25 control) with lateral cephalograms (Class II malocclusion) who were in need for orthodontic treatment at department of Orthodontics, Manipal College of Dental Sciences, Manipal. All the subjects included in both the groups were radiographed as a part of diagnostic procedure and treated appropriately based on the required treatment plan of subject. No special effort was made to obtain diagnostic radiographs for the purpose of our study. Only the radiographs which were taken in due course of treatment or treatment plan were used. The data thus obtained during the course of treatment in both the groups were used for this study. A detailed protocol was previously presented to the Institutional Review Broad (IRB), MCODS, Manipal University, Manipal, India. It was considered exempt from IRB approval as the diagnostic procedures were conducted as a part of treatment procedure. However, an informed consent was sought from all the subjects, which stated that the diagnostic records might be used for academic and educational purposes. This procedure of consent is mandatory in our institution before starting any type of treatment. Parental consent was also obtained whenever it was deemed necessary.

The inclusion criteria for the subjects were.

1. ANB: 4.5–6°.
2. Class II molar relationship with full complement of teeth except third molars.
3. Mandibular plane angle 17–25°.
4. Nasal breathers.
5. Clinically convex facial profile.
6. No associated craniofacial abnormalities.

All the subjects were treated by standard edgewise mechanotherapy. Medium size LHG with cervical traction pad (Dentauram, Pforzheim, Germany) was used in test group. The outer bow of the face was adjusted at 15° upward to the occlusal plane so that the force application point was located approximately between the roots of first and second premolars. A cervical traction of 350 grams per side was applied. (Fig. 1) All the subjects in the test group were instructed to wear the LHG 14–16 h per day. No Class II elastics were used in the test group.

The subjects in the test group were asked to maintain a diary for recording headgear wearing patterns which was also cross checked by their parents. Headgear compliance was measured according to the diary notes and signs of headgear use such as mobility of first molars, cleanliness of the neckstrap/headgear. The subjects in the control group did not wear LHG or Class II elastics. Baseline and follow-up cephalograms in both the groups were taken at the natural head position (NHP) and four postural variables (two craniocervical and two cervicohorizontal) were used to determine the changes in the head position. A mirror eye reference was used to obtain the natural head position as described in the previous studies (Cooke and Wei, 1988; Peng and Cooke, 1999). The craniocervical angles were NSL/CVT (Angle 1) the angle between the nasion (N) – sella (S) line and CVT, and NSL/OPT (Angle 2); the angle between the nasion (N) – sella (S) line and OPT. The cervicohorizontal angles were CVT/HOR (Angle 3) angle between CVT and the true horizontal and OPT/HOR (Angle 4); the angle between OPT and the true horizontal (Fig. 2). A thin metallic scale was placed in front of the patient's face to obtain true vertical reference line. (Fig. 2) The lateral cephalograms were hand traced by the single investigator. All the cephalograms were taken on the same radiographic unit (Proline Cephalostat, Planmeca, Finland). Skeletal age of the subjects was also assessed in both the groups using cervical vertebrae maturation method.

2.2. Error study

To evaluate the intra-examiner reliability and reproducibility of landmarks in the cephalometric tracings, a total of 10 lateral cephalogram subjects were selected at random from each group and retraced. Results of the paired sample *t*-test showed

Figure 1 Extra oral picture showing a patient wearing low pull headgear.

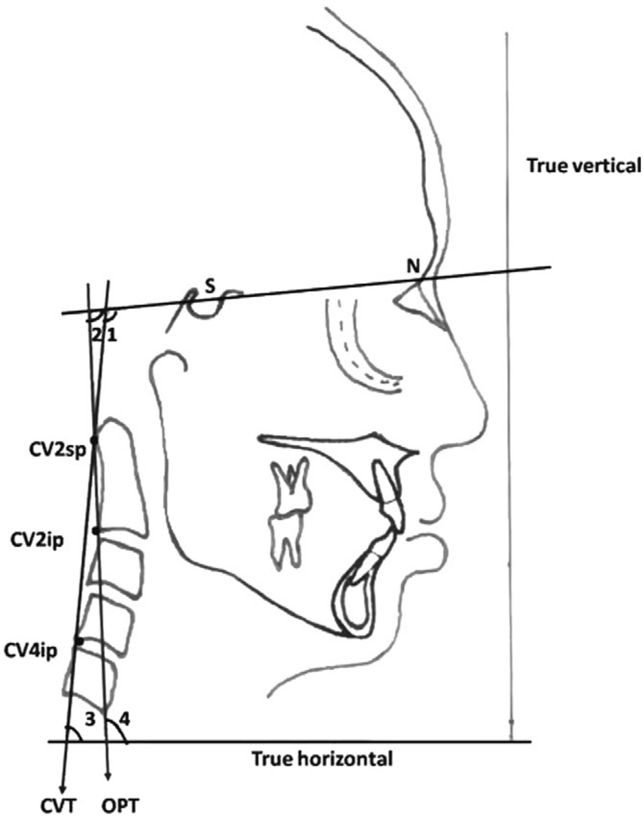

Figure 2 Postural measurements: reference points: N; nasion, S; sella, *Cv2sp*; supero-posterior point of 2nd vertebrae, *Cv2ip*; infero-posterior point of 2nd vertebrae, *Cv4ip*; infero-posterior point of 4th vertebrae. Reference planes: true vertical; marked by drawing the radiographic image of the vertical metallic scale, True horizontal; drawn perpendicular to the true vertical, CVT; cervical vertebral tangent (the reference line between Cv2sp and Cv4ip), OPT;Odontoid process tangent (the reference line between Cv2sp and Cv2ip). Postural angles: NSL/CVT (Angle 1); the Angle between the nasion (N) – sella (S) line and CVT, NSL/OPT (Angle 2); the angle between the nasion (N) – sella (S) line and OPT, CVT/HOR (Angle 3); the Angle between CVT and the true horizontal, OPT/HOR (Angle 4); the Angle between OPT and the true horizontal.

no significant differences between the first and second sets of evaluations at the 95% confidence interval.

2.3. Statistical analysis

All statistical analysis was performed using the SPSS software package (SPSS for Windows version 14.0, SPSS Inc, Chicago). Descriptive data that included arithmetic mean and standard deviations of pre and post study period measurements were calculated for both groups and were used for analysis. A paired *t*-test ($t(32) = 1.126$, $p = .011$) was performed within the groups to compare the postural changes that occurred during the study period. Furthermore, differences in the means of the postural variables between the groups were assessed by unpaired t tests. A *p value* < 0 .05 was considered statistically significant.

3. Results

Test and control groups consisted of 30 (mean age: 11 ± 1.5 years) and 25 males (mean age: 11 ± 1.6 years) respectively. The average treatment time for the test group was 12 ± 2.02 months and the average observation period for the control group was 11 ± 1.03 months. Five subjects were excluded from the test group due to non-compliance in the headgear use.

There was no significant difference in the mean baseline and follow-up values for any of the four postural variables in test [Angle 1: df = 54, $p = 0.102$; Angle 2: df = 54, $p = 0.28$, Angle 3: df = 54, $p = 0.191$; Angle 4: df = 54, $p = 0.183$] and control groups [Angle 1 df = 54 $p = 0.144$, Angle 2 df = 54, $p = 0.745$, Angle 3 df = 54, $p = 0.76$, Angle 4 df = 54, $p = 0.971$] (Table 1). The difference in the baseline and follow-up values was calculated and compared between test and control groups. There was no significant difference in the mean for any of the four postural variables between test and control (Angle 1: df = 53 $p = 0.924$; Angle 2: df = 53, $p = 0.338$; Angle 3: df = 53, $p = 0.448$; Angle 4: df = 53, $p = 0.398$) (Table 2).

4. Discussion

Our study evaluated the effect of LHG on head position in 30 subjects over a period of 10–12 months. Skeletal maturity sta-

Table 1 Comparison of baseline and follow-up of postural angles for headgear and control group.

Group		Baseline		Follow-up		*p* value
		Mean	SD	Mean	SD	
Head gear	Angle 1	102.47	6.47	103.90	6.46	0.102
	Angle 2	99.40	6.68	100.30	5.60	0.28
	Angle 3	87.50	4.86	86.37	3.73	0.191
	Angle 4	90.27	5.09	89.18	3.91	0.183
Control	Angle 1	100.04	5.00	101.60	5.59	0.144
	Angle 2	96.96	6.33	96.64	5.58	0.745
	Angle 3	88.72	5.27	88.48	4.54	0.760
	Angle 4	92.64	7.07	92.68	5.15	0.971

Angle 1: NSL/CVT, Angle 2: NSL/OPT, Angle 3: CVT/HOR, Angle 4: OPT/HOR.
Paired *t* test.

Table 2 Comparison of mean difference (follow-up – baseline) between test and control groups.

Mean difference	Group				*p* value
	Head gear		Control		
	Mean	SD	Mean	SD	
Angle 1	1.43	4.65	1.56	5.16	0.924
Angle 2	.90	4.47	−.32	4.87	0.338
Angle 3	−1.13	4.64	−.24	3.89	0.448
Angle 4	−1.08	4.35	.04	5.42	0.398

Angle 1: NSL/CVT, Angle 2: NSL/OPT, Angle 3: CVT/HOR, Angle 4: OPT/HOR.
Independent sample *t* test.

tus of the subjects in both test and control groups was assessed by cervical vertebrae maturation method. Subjects in both the groups were well matched with respect to chronological age as well as the skeletal age. There were no statistically significant changes observed in head position in either test or control group during the study period.

Bjork (1955) reported that subjects with an obtuse cranial base angle were more likely to exhibit facial retrognathism and elevated head position. This was followed by a number of cross-sectional studies which demonstrated an association between head position and craniofacial morphology (Solow and Tallgren, 1976; Solow and Siersbaek-Nielsen, 1986, 1992). Solow and Kreiborg (1977) put forward the 'soft tissue stretching hypothesis' to elucidate the association between extended or flexed cranial position and changes in craniofacial development. This change was related to the stretching and elongation of the various tissues that are attached to and support the jaw.

LHG is generally used for 12–14 h per day over a period of 6–12 months to redirect the maxillary growth. Considering that LHG exerts orthopedic forces directly on the cervical vertebra over a considerable period of time and along with a force vector of the headgear which passes from the center of resistance of the cranium, it may easily tip the head forward or cause its flexion. Usumez et al. (2005) evaluated the effect of LHG on the dynamic measurement of head position in 16 subjects and reported a statistically significant cranial flexion in 14 subjects immediately after insertion of the headgear. In our study, no significant changes in head position were observed after a period of 10–12 months. The difference in the results may be attributed to a very short observation period in the previous study. Yavuz et al. (2007) evaluated head position in subjects wearing LHG over a period of 8–10 months and compared it to a control group. They reported no change in head position over a period of 9 months either in the treatment group or in the control group. The results of our study were in accordance with the study done by Yavuz et al. (2007). This result can be partly explained by the nature and duration of the LHG force. (Intermittent and average – 12–14 h/day).

Many previously published studies report a comprehensive set of associations between craniofacial morphology and the position of the head in relation to the cervical column. Orthopedic forces of cervical pull headgear may influence cranial base by producing a counterclockwise tilting of the spheno-ethmoid plane during 3–4 years of treatment with a headgear (Wieslander, 1974). Review of the literature suggests that the position of the head in relation to the cervical column is strongly associated with structural variations in the sagittal and vertical dimensions of the face. Positive associations have also been demonstrated between head position and both mandibular and maxillary anterior dento-alveolar height as well as with the inclinations of the upper and lower occlusal planes (Solow and Tallgren, 1977). An excessive cranio-cervical angulation is also associated with lower anterior crowding (Solow and Sonnesen, 1998).

Given that postural adaptation entails altered muscle activity; it is possible that if the altered posture is sustained for a sufficient time during growth, permanent changes in musculoskeletal relations may be produced. In light of these views, significant consideration should be given to the clinical procedure such as wearing of headgear that may have an effect on head position. In our study, there were no statistically significant changes observed in head position in either test or control group over the observation period of 10–12 months. However, it was observed that the changes in postural variables were not uniform in both groups, and all measurements used in the study showed a considerable amount of variability with high standard deviation values. This indicates that different subjects showed dissimilar responses in both groups. Hence, we recommend that long-term investigations including a larger sample of patients treated with LHG would shed more light to determine its effect on head position.

5. Conclusion

- Within the limitation of the studies, the head position exhibited no significant changes over a period of 10–12 months either in control group or in the group treated with low pull headgear.
- This study attempts to clarify to the clinicians that there was no deleterious effect on head position with the application of orthopedic force.

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